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MULTIFARIOUS ASPECTS OF TANNERY WASTE AND ITS MANAGEMENT IN INDIA

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ABSTRACT

Tanning is an ancient craft in India and plays an important role in the country's economy. The industry flourishes in conditions of natural advantage offered by large cattle population, which supply raw materials amounting for 15% of cattle, 46% of buffalo,17% of goat and 4% of sheep of the world. Although tanning industry has been in existence for a long time, the problem of environmental pollution received serious consideration only in recent years. The pollutants from large number of tanneries in the country have caused considerable damage of water courses, affecting drinking water supply and irrigation. It is realized that the untreated wastewaters when allowed to stagnate as is being done in most cases, gives rise to odour nuisance, unsightly appearance, creating ground and surface water pollution. The industry is generally associated with a noxious smell arising from its raw materials, solids, Liquids and gaseous wastes emanating from the industry adopting medieval methods of processing. Increasing in number of tanning units and the lack of application of suitable methods of disposal of the wastes, the problem of environmental pollution is likely to aggravate further in coming years with a severe impact on the environment, necessitating early measures for the control of pollution from tanneries. This paper gives an overview of tanning industry inclusive of its waste characteristics, pollutional impacts and various disposal techniques, cleaner technology and waste minimization.

KEYWORDS: Cleaner Technology, Cattle population, noxious, aggravate, waste minimization, Tanning & Raw materials

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INTRODUCTION

The process of leather production is more an art than science since by utilizing the same raw materials and tanning agents one can get a very good soft leather or a rough and hard leather by merely changing the conditions of the processing[4]. Animal skin consists of an epidermia, a layer of fatty tissues called areolar, and the inner corium and the semi-soluble protein, called collagen present in corium is converted in tough, flexible, insoluble and highly durable leather through tanning operations[5]. The medium sector in India alone contributes about 60-70% of the total production and 20% of the exports of leather and leather goods[1]. The total annual production of leather industry in the country is about 500-600 crores, out of which Rs 300 crores are earned by the export of semi-tanned leathers, semi-finished leathers, finished leathers, leather goods and footwear[2]. Leather and leather goods industry is one of the biggest small-scale industries in India and this industry is scattered unevenly in the country.

The main centers of tanning industry in India are located in West Bengal, Tamil Nadu, Uttar Pradesh, Maharashtra, Punjab, Karnataka, Orissa, Andhra Pradesh and Rajasthan. About 70% of the total export of leather and leather products are from Tamil Nadu. There are 433 recognized tanneries in Tamil Nadu, out of which 104 units are mechanized [3].

Table 1 Characteristics of Wastewater Generated From Raw to Semi Tanned Units as Per I.S 5183:1977

Source of Effluent	pH	Total solids	Suspended Solids	BOD
Soaking	7.8-8.0	8000-28000	2500-4000	1100-2500
Liming	10-12.5	16000-45000	4500-6500	6000-9000
Deliming	3.0-9.0	1200-12000	200-1200	1000-2000
Vegetable tanning	5.0-6.8	8000-50000	5000-20000	6000-12000
Pickling	2.9-4.0	16000-45000	600-6000	600-2200
Chrome Tanning	2.6-3.2	2400-12000	300-1000	800-1200
Composite	7.5-10.0	10000-25000	1250-6000	2000-3000

All values except pH are expressed in mg/L.

POLLUTIONAL EFFECTS

Impact of Gaseous Pollutants on Environment

The problems associated with gaseous pollutants from a tannery include noxious smell hydrogen sulphide and dust. The effect of noxious smells on People is primarily a nuisance effect. Certain intense odours may lead to nausea.

Control of Gaseous Pollution in Tanneries

Source control is the most effective means of abating odour. Preventive measures like good sanitation practices are usually cheaper than control measures. Odours arising out of putrefaction of solid wastes like fleshings, trimmings etc and liquid wastes may be greatly reduced by the proper use of disinfectants, spray and ventilation systems.

SOURCE CONTROL OF ODOUR CAN BE DONE BY ANY ONE OF THE FOLLOWING METHODS [9]

- Drawing the odourous air from the working atmosphere by exhaust fans and diluting with relatively clean air.
- Removal of causative impurities from the tannery
- Masking the odour with objectionable additives
- Removal of odour bearing dusts by cyclone separators
- Sorption of odourous gases through a granular sorbents like active carbon

IMPACT OF LIQUID WASTES ON ENVIRONMENT

The discharge of untreated wastewaters in water courses may affect the physical, chemical and biological characteristics of the water and deplete dissolved oxygen from the water bodies. The high oxygen demand of tannery wastes is due to proteins, fatty matter and tannins. High pH, excessive alkalinity, salinity suspended matter, temperature and sulphides are injurious to fish and other aquatic life in streams. Sulphide present in tannery wastewaters can cause unpleasant odour problems, react with iron and other metals causing black precipitate, render the water unfit for industrial uses and affect fish and other aquatic life[6]. Nitrogen and phosphorous from tannery effluents encourage uncontrolled growth of algae and other aquatic plants in water bodies. High amounts of chloride present in tannery wastewaters can make the receiving water less available for drinking, industrial, and agricultural purposes. [7]. It is reported that discharge of tannery wastes into surface waters like channels and tanks have increased their salinity in objectionable levels. The discharge of untreated tannery wastes into water course may also increase the turbidity of water thereby reducing light penetration and impairing photosynthetic activity of aquatic plants. The health hazards in man and animals through micro-

organisms carried by hides and skins. Total dissolved solids and chloride concentration of ground water has been increased due to ponding, spreading out or discharging of tannery waste into dry river beds. When the tannery waste gains access to cultivable lands or when the lands are irrigated with such waste fertility of the soil is affected[8]. The problems associated with discharge of tannery wastes into municipal sewers, include incrustation of sewers, sewer clogging and other forms of interference with sewage treatment.

CONTROL OF WATER POLLUTION IN TANNERIES

In plant measures for reduction of waste volume and pollutional load

This includes reduction of water consumption in the tannery, segregation of soak liquor and lastly recovery of the by-products and reuse of various process liquors.

REDUCTION OF WATER USAGE IN A TANNERY

Good housekeeping is the first step to prevent wastage of water and materials in a tannery. Economical use and reuse of water are necessary to reduce the volume of the effluent

- Better housekeeping
- Alteration of processes and low float systems to use less water.
- Separation of cleaner fractions of the waste for direct reuse without treatment and
- Recycle after complete or partial treatment.

WASTE REDUCTION DURING HIDE PRESERVATION

The present method of preserving hides and skins by salt curing is as old as the tanning itself, but the disposal of its effluents remains a problem even today. This problem can be solved by changing the process of curing with non-toxic and less polluting agents. Prasad et al[10]reported use of curing agents other than saltnamely Biocide-x, Neem bitters and 2-Hydroxy4-methoxy-benzaldehyde

Waste Reduction during Beam House Operations

Modifications of the beam house processes such as use of biodegradable surfactants and restrictive use of bacteriocides during soaking and alternative methods of dehairing are worth adopting[11,12,13].

Waste Reduction during Vegetable Tanning

The use of drums for vegetable tanning is found to allow smaller floats and give higher fixation of vegetable tannins compared to pit vegetable tanning systems.

Waste Reduction during Pickling and Chrome Tanning

In the case of chrome tanning process a reduced concentration of chromium in the effluent can be achieved by improving the fixation chrome, reuse of chrome liquor and precipitation of chromium from the chrome liquor with an alkali and redissolving and reusing the chrome precipitate.

Waste Reduction from Post Chrome Wet Processes

Modern technology has long accepted the possibility of combining fat liquoring and dyeing processes using low float levels and no great problems are encountered in producing a low level of effluent with low pollutant level. Judicious pH adjustment allows almost complete fixation of reagent during dyeing and fat liquoring.

REUSE OF PROCESS LIQUORS

Reuse of process liquors offers a good method for reducing waste volume. It is reported that used lime liquors can be reused upto 13 cycles[14]

- Primary treatment
- Secondary treatment
- **C**hemical treatment

Table 2: Removal Efficiencies Attained by Some Coagulants [15]

Coagulant	Dose Mg/L	TSS Removal Percent	BOD Removal Percent
Ferric Sulphate	100	88	77
Anionic Polymer	10	90	70
Ferric chloride Plus	25	92	75
Anionic Polymer	1	92	-
Hexametaphosphate	50	85	-
Magnesium Carbonate	50	80	-
Alum plus	100	-	-

IMPACT OF SOLID WASTE ON ENVIRONMENT

Generation of solid wastes, during various tanning operations if not properly utilized or disposed they are likely to cause a number of problems. Salt dust causes ground water pollution, Hair and lime sludge chokes the drains, raw and green fleshings gives noxious smells.

CONTROL OF SOLID POLLUTION IN TANNERIES

In general where tanning industries have been established, there usually a simultaneous growth in industries, which uses these wastes as a useful products. This pattern is especially helpful to the tannery industry in the case of obnoxious rag, limed fleshings, trimmings and splits which are lifted by glue, gelatin and fat rendering units.

AEROBIC PROCESS

Table 3: Comparative Statement for Alternative Type of Treatment System

Description	Conventional Aerated Sludge	Activated sludge process (Extended aeration system)
BOD removal	70-80	90-98
Detention time days	3-8	0.5-1.5
Land area requirement m^2	700-900	250-350
Equipment Required	Aerators only	Aerators Recycle pumps
Oxygen requirement kg/kg BOD Removal	0.6-0.8	1.0-1.2
Power capacity, HP	2.0-3.0	7.0-10.0
Nitrification	None Manual	Likely
Sludge Handling	Desludging once in 5-10 years	No digestion, drying beds

Table 4: Performance Evaluation of Various Reactor Types

Characterstics	ABF (Anaerobic Baffled Filter)	AF (Anaerobic Filter)	UASB Upflow Anaerobic Sludge Blanket
Influent COD, mg/L	7122	7026	7133
Organic loading COD/L/d	7.79	7.1	7.6
HRT, hours	22	23.5	22.5
Temperature ^{o}c	25-37	30.37	30-37
Effluent Characteristics			
COD(soluble),mg/l	353	1078	1049
BOD(soluble, mg/l	101	478	538
Tannin, mg/l	99	156	156
Volatile acids mg/l	100	777	406
Percent removal efficiency			
COD	95	84.6	85.3
BOD	97.6	87.5	86
Tannin	89.3	82.3	83
Methane production,L/L/d	2.3	1.7	1.9
Methane Content %	66	65.4	64

Table 5: Effluent Characteristics

COD(Soluble)mg/l	353	1078	1049
BOD(Soluble)mg/l	101	478	538
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Table 6: Percent Removal Efficiency

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Tannin	89.2	82.3	83.0
Methane content L/L/d	2.3	1.7	1.9
Methane Content %	66	65.4	64.0

TREATMENT THROUGH NON-CONVENTIONAL METHODS

Use of Water Hyacinth for Tannery Waste Treatment

Efficient in removing BOD, inefficient in removing total solids[16].

Use of Fungi for Tannin Biodegradation

One of the promising approaches to the problem of microbiological treatment of tannery wastes is to use additives that would enhance the growth of microorganisms in tannin-amended medium. Using fungi would be a promising approach in the treatment of tannery effluent[17].

INTERMITTENT SAND FILTERS

It could be economically employed by small tanneries provided that sufficient space is available for locating the filter beds [18].

AGRICULTURAL UTILIZATION OF TANNERY EFFLUENTS

Tannery waste can be used as a liquid fertilizer and provide significant N and lime for crops but application at high rates may be limited by salt content, heavy metal accumulation or potential movement of NO_2 –N into ground water.

DISPOSAL OF TANNERY WASTE

Spray Irrigation

Once the operating problems are overcome, the process apparently is successful in disposing of the wastes without nuisance. However large amounts of land, odour nuisance and ground water contamination with NaCl Proved to be decisive factors in selection of this process.

Table 7: Colour Removal

Whole Effluent Treatment	Remarks	Segregated Effluent Treatment	Remarks
Flocculation	Simplest for use with conventional plant No single flocculant is likely to be universally effective		
Carbon Column Adsorption	Probably the best tertiary treatment Frequency of regeneration is likely to ne the limiting factor	Carbon column adsorption, Resin column adsorption	

RAPID AND EFFECTIVE WITH MANY CLASSES OF DYES

Very frequent regeneration may be required some similarities to carbon column, Multi-stage unit probably essential claimed to be effective in removing all dyes. Power usage may be high-catalytic oxidation most effective with concentrated liquors. Perhaps more specific for removal of colour than of other waste components. Electrolytic separation very effective but has high running costs. Unable to provide complete waste treatment alone. Membrane reliability uncertain under these conditions-Reverse Osmosis.

CLEANER TECHNOLOGIES INCLUDES THE FOLLOWING ASPECTS

- Less pollution discharged into natural environment
- Less waste generation
- Less demand for natural resources

THERE ARE THREE BROAD CATEGORIES OF CLEANER TECHNOLOGIES VIZ

Low and non waste technologies of production aimed at waste minimization at all points in the cycle of production through process changes, good housekeeping, recycle and reuse equipment redesign and product reformulation

Recycle technologies designed to recover raw materials, energy, water and byproducts in the course of EOP(end-of-pipe) waste treatment.

Waste utilization technologies for reclamation and utilization of wastes as secondary raw materials, or for processing of wastes to manufacture products with various end uses.

Cleaner Technologies - Indian Scenario

In India the concept of LNWT (Low and non waste technologies) has been applied in the area of liquid waste management. Examples of waste volume reduction, waste recycle and reuse, and byproduct recovery in several industries such as textile, tannery, metal finishing, beverages, pulp and paper, distillery are well documented.

CLEANER TECHNOLOGIES FOR TANNNING INDUSTRY

In-Plant Control Measures for a Tanning Industry is Divided into Following Four Steps

- Reduction of water usage in a tannery
- Process modification to reduce pollutional load
- Segregation of all streams of effluents and its treatment
- Recovery and utilization of by-products.

THE VARIOUS CONTROL MEASURES OF IN-PLANT POLLUTION AND END-OF-PIPE TREATMENT AVAILABLE TO THE TANNING INDUSTRY ARE

- Better housekeeping
- Separation of cleaner fractions of waste for direct reuse without treatment
- Salt less soaking of hides and skins using biocide.
- Usage of enzyme as soaking aid
- Replacement of pentachlorophenol by a safer preservative.
- Enzymatic unhairing thus avoiding pollution due to sulphide.
- Elimination of concentrated gaseous discharges of chemicals like ammonia, formaldehyde, organic solvents etc by adequate precautions in both finishing methodology and type of equipments fitted with high chimneys for dispersal and discharge of vapours.
- Installation of air pollution control measures in boulder itself to arrest suspended particulate matters.

WASTE MINIMIZATION

In waste minimization maximum efforts should be made to avoid or minimize the waste or to use the waste as byproducts.

The Principles of Waste Minimization can Best be Described by Following Points

- By avoiding or eliminating the production of waste, its potential risk to health and the environment is totally removed. This may be carried out by choosing an alternative process when designing a production unit initially, or by altering the process of an existing plant.
- Reduction and minimization of waste streams within an industry is possible by careful consideration of all the processes and activities, which give rise to the production of the waste.
- Waste recycling and reuse have become popular and topical issues throughout the world in the last few years.
- If waste cannot be eliminated or recycled only destruction of the waste will ensure that the environment does not suffer from the addition of the waste. This of course is especially true in the case of toxic and hazardous waste. Typical examples of waste destruction are cyanide oxidation, reduction and precipitation of chromium from

hexavalent to trivalent form, the combustion of organic solvents and the degradation of organic compounds by the use of biological agents.

- When all avenues delineated above have been exhausted as being non-viable due to excessive economic constraints, then disposal into the environment should be considered.

Apart from above Five Points there are Number of Other Initiatives Which Can be Implemented to Increase this Worthwhile Change

- For promoting waste utililzation, the Union Government should seriously consider part or total exemption of sales tax and excise duties for products made wholly or partly of materials which otherwise would be part of the waste stream.
- Subsidies or concessions for collection, storage and transport of waste should be considered by the government if it can be proven that such changes in waste management practices will lead to significant improvement in the protection of health and the environment.
- Special concession should be given for plants proposed for processing of waste into useful products. This should include reduction in import duty on machinery required to be purchased from outside India in order to establish such plants.
- The National Waste Management Council has already proposed the development of a national waste management strategy and the establishment of a special waste management institute to advise the Government on the formulation of policies relating to the financial, social and legal aspects of waste minimization[19].

Waste Water Minimization and Recycling

Conservation of water and reuse of wastewater after suitable treatment, and practice of waste minimization will be very beneficial.

Specific methods have been developed for waste minimization and reclamation of water from industrial effluents for reuse is to reduce the waste load present in the effluent.

The methods generally adopted are

- Changes in process technology
- Modification of process equipments
- Segregation of process wastewater from the uncontaminated waste streams from off-site utilities like water purification, boiler house and cooling systems

REUSE OF WATER IN INDUSTRY

It can be seen that a substantial proportion of the wastewater could be reused in each type of the water-intensive industries and hence there would be a sizeable reduction in the waste volume discharged into the environment. However in medium and small scale industries recycling of effluents is limited and requires to be identified only by carrying out an industry specific survey in each type of industry. Water usage of different units such as large, medium and small scale is highly variable hence it is difficult to propound a general scheme of wastewater minimization and reduction in pollution

load. The programme for waste minimization requires to be considered individually for each industrial unit in order to evolve a rational and feasible plan.

CONCLUSIONS

This paper gives an idea about various factors like characteristics of tannery waste as per IS standards, impacts of gaseous, solid and liquid wastes on environment and its control measures, waste reduction during various operations, reuse of liquors, removal efficiencies by various coagulants, comparative Statement of conventional aerated sludge and Activated sludge process, performance evaluation of various reactor types, treatment of tannery waste by non conventional methods, disposal of various types of tannery wastes, cleaner technologies, waste minimization and colour removal. Which will be helpful to the tannery industries, students and researchers who is going to do research on tannery waste.

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